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Modeling and Design of an Electro-rheological Fluid Based Haptic System for Tele-operation of Space Robots

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ABSTRACT

For many years, the robotic community sought to develop robots that can eventually operate autonomously and eliminate the need for human operators. However, there is an increasing realization that there are some tasks that human can perform significantly better but, due to associated hazards, distance, physical limitations and other causes, only robot can be employed to perform these tasks. Remotely performing these types of tasks requires operating robots as human surrogates. While current "hand master" haptic systems are able to reproduce the feeling of rigid objects, they present great difficulties in emulating the feeling of remote/virtual stiffness. In addition, they tend to be heavy, cumbersome and usually they only allow limited operator workspace. robotics robonaut

In this paper a novel **haptic interface** is presented to enable human-operators to "feel" and intuitively mirror the stiffness/forces at remote/virtual sites enabling control of robots as human-surrogates. This haptic interface is intended to provide human operators intuitive feeling of the stiffness and forces at remote or virtual sites in support of space robots performing dexterous manipulation tasks (such as operating a wrench or a drill). Remote applications are referred to the control of actual robots whereas virtual applications are referred to simulated operations. The developed haptic interface will be applicable to IVA operated robotic EVA tasks to enhance human performance, extend crew capability and assure crew safety.

The electrically **controlled stiffness** is obtained using constrained **ElectroRheological Fluids** (ERF), which changes its viscosity under electrical stimulation. Forces applied at the robot end-effector due to a compliant environment will be reflected to the user using this ERF device where a change in the system viscosity will occur proportionally to the force to be transmitted. In this paper, we will present the results of our modeling, simulation, and initial testing of such an electrorheological fluid (ERF) based haptic device.